

Rocky Flats, Colorado, Site Revegetation Plan

January 2009



U.S. DEPARTMENT OF
ENERGY

Office of
Legacy Management

This page intentionally left blank

**U.S. Department of Energy
Office of Legacy Management**

**Rocky Flats, Colorado, Site
Revegetation Plan**

PREDECISIONAL DRAFT

This page intentionally left blank

Contents

1.0	Introduction	1
1.1	Goals and Objectives.....	1
1.2	Site Description and History	2
2.0	Revegetation (Seeding)	4
2.1	Revegetation Planning Assumptions.....	4
2.2	Revegetation Best Management Practices	4
2.3	Soil Characterization	5
2.4	Prohibited Species	5
3.0	Long-Term Monitoring and Management.....	5
3.1	Revegetation Management.....	6
3.2	IA Revegetation Success Criteria.....	7
3.3	Revegetation Monitoring Methodology	7
4.0	References	9

Figure

Figure 1. Locations of the Central Operable Unit and Peripheral Operable Units at the Rocky Flats Site	3
--	---

Table

Table 1. Daubenmire Cover Class System	8
--	---

Appendixes

Appendix A	Revegetation Seed Mixes
Appendix B	IA Revegetation Areas Soil Characterization Data from Summer 2003
Appendix C	Qualitative Revegetation Evaluation Form

This page intentionally left blank

1.0 Introduction

The Rocky Flats Site (Rocky Flats) is under the jurisdiction of the U.S. Department of Energy (DOE) Office of Legacy Management. S.M. Stoller Corporation conducts long-term surveillance and maintenance activities at Rocky Flats under the Legacy Management Support (LMS) contract. Vegetation management is conducted as part of the surveillance and maintenance activities at Rocky Flats, which include activities conducted pursuant to the Rocky Flats Legacy Management Agreement. That agreement established the regulatory framework to implement the final response action selected and approved in the Rocky Flats Corrective Action Decision/Record of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act; the Resource Conservation and recovery Act; and the Colorado Hazardous Waste Act to ensure that the response action remains protective of human health and the environment.

The Rocky Flats closure activities included the removal of existing buildings and structures within the former Industrial Area (IA) of the site. As the buildings and other facilities and structures were removed across the site, revegetation of the areas was conducted to stabilize the soil, minimize erosion, and promote the establishment of native plant communities. In 2007, much of the former Buffer Zone was transferred to the U.S. Fish and Wildlife Service to become the Rocky Flats National Wildlife Refuge. The portion of the site retained by DOE comprises the IA and surrounding ponds and landfill areas. The DOE retained area is known as the Central Operable Unit (COU), and the refuge areas are part of the Peripheral Operable Unit (POU) (Figure 1).

1.1 Goals and Objectives

The following goals and objectives were established for the original revegetation effort at the site and apply to any future revegetation efforts:

Goal 1. Provide a vegetative cover in disturbed and degraded areas to stabilize the soil and minimize erosion.

Goal 2. Wherever possible, avoid or minimize the loss of native habitat where it is still present.

Goal 3. Develop sustainable native plant communities that provide habitat for native wildlife species that occur at the site. The goal is revegetation, not restoration.

Goal 4. If warranted, remove areas of planted, exotic plant species that were used for landscaping purposes.

Goal 5. Control noxious weeds in revegetation areas using an appropriate Integrated Weed Management Program strategy outlined in the Vegetation Management Plan (DOE 2008).

As defined for this plan, “revegetation” means reseeding the dominant native plant species for a given plant community type. Revegetation differs from restoration, which is defined as the reestablishment of the pre-disturbance native plant communities and all the associated natural processes and functions. However, although initially the common native plant species are being

seeded, other grasses, forbs, or shrubs found on the native prairie at the site could be seeded and planted at a future time, if desired, to provide greater diversity to the revegetation locations.

1.2 Site Description and History

At an elevation of approximately 6,000 feet, the site (both COU and POU areas) contains a unique ecotonal mixture of mountain and prairie plant species resulting from the topography of the area and its proximity to the mountain front. The POU, the area surrounding the former IA, is one of the largest remaining undeveloped tracts of its kind along the Colorado Piedmont. The Colorado Natural Heritage Program has identified a number of plant communities present at the site as increasingly rare and unique. These communities include the xeric tallgrass prairie, tall upland shrubland, wetlands, and Great Plains riparian woodland communities. Small inclusions of a number of other increasingly rare plant communities are also found on the site.

The upper flat surfaces at the site (pediment tops) are composed of Rocky Flats alluvium. The soil types on this surface are classified as Flatirons very cobbly sandy loam and Nederland very cobbly sandy loam (SCS 1980). The vegetation on this surface is predominantly xeric tallgrass prairie on the western portions of the site and gradually changes to a needle and thread grass community as the alluvium thins to the east. Based on evidence from the current vegetation map, soil types, and historical aerial photographs, much of the COU was probably xeric tallgrass prairie prior to its construction. Common species on the xeric tallgrass prairie include *Andropogon gerardii*, *Andropogon scoparius*, *Muhlenbergia montana*, *Stipa comata*, *Bouteloua gracilis*, *Bouteloua curtipendula*, *Carex heliophila*, *Poa compressa*, and a variety of other graminoid and forb species. The dominance of these species varies from location to location.

The hillsides at the site are dominated by the mesic mixed grassland community. Soils on the hillslopes are classified as Denver-Kutch-Midway clay loams (SCS 1980). Common species on the mesic mixed grasslands include *Bouteloua gracilis*, *Bouteloua curtipendula*, *Agropyron smithii*, *Stipa viridula*, *Poa pratensis*, *Poa compressa*, *Bromus japonicus*, and other forbs and graminoids. The hillside areas in the COU were largely composed of this community prior to disturbance.

Riparian areas at the site are typically characterized by *Populus deltoides*, *Salix exigua*, *Amorpha fruticosa*, *Symphoricarpos occidentalis*, *Rosa arkansana*, and various wetland herbaceous plants such as *Carex nebrascensis*, *Juncus balticus*, and *Spartina pectinata*. The soils on the floodplains and stream terraces at the site are classified as Haverson loams (SCS 1980). Within the COU, historical aerial photographs show that two small tributaries to Walnut Creek drained the former IA and would have contained some wetland and riparian vegetation. These tributaries, however, were modified and the channels moved for construction of some of the buildings at the site.

Prior to purchase by DOE, most of the land where the site occurs was rangeland that had been heavily overgrazed (Clark et al. 1980). Historical aerial photographs show little riparian woodland or shrubland vegetation along the streams at the site, likely attributable to overgrazing in the riparian corridors. After DOE purchase, grazing was stopped and the native plant communities were allowed to return with little or no management.

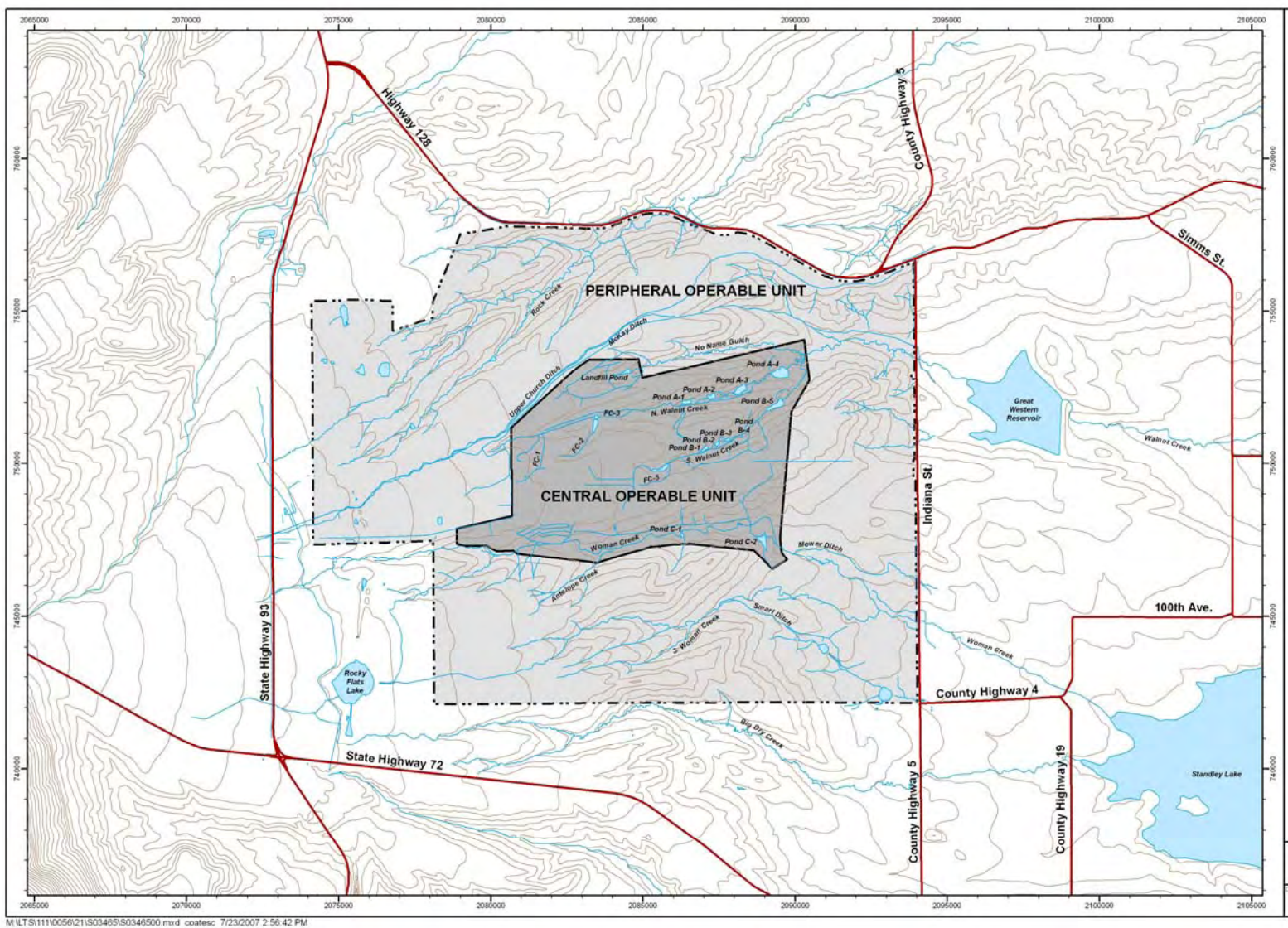


Figure 1. Locations of the Central Operable Unit and Peripheral Operable Units at the Rocky Flats Site

2.0 Revegetation (Seeding)

2.1 Revegetation Planning Assumptions

This revegetation plan is intended as guidance. It may be modified, altered, or departed from as specific locations warrant or as particular needs arise. This plan is specifically developed for use in the COU; however, because it is based on the native plant communities in both the COU and POU, it could also be used by the U.S. Fish and Wildlife Service (USFWS) on the refuge if desired. This plan applies to revegetation locations in the COU, excluding those areas covered specifically by regulatory agreements that may have other requirements. Preble's mouse and wetland mitigation revegetation are not addressed in this document. The guidance in this plan may be used for these mitigation areas; however, Preble's mouse and wetland mitigation issues may have more specific requirements that are outlined in the documents that govern the mitigation. Disturbance and mitigation of Preble's mouse habitat are addressed in USFWS consultation documents such as biological evaluations, biological assessments, and biological opinions for specific projects. Disturbance of jurisdictional wetland areas would require an approval by the U.S. Environmental Protection Agency or U.S. Army Corps of Engineers that would provide specifications for the wetlands, including reconstruction or mitigation. The wetland mitigation issues are covered in the *Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan* (DOE 2006). This plan also does not address revegetation of soil covers (e.g., Present Landfill, Original Landfill), which may have specific requirements for vegetation based on the purpose of the covers.

2.2 Revegetation Best Management Practices

Appendix A contains the seed mix specifications. Different seed mixes are provided depending on the topographic location and hydrologic conditions at the revegetation location. The following seed mixes are used for revegetation at the site:

- Flat areas seed mix—use on the pediment tops at the site.
- Hillside slope areas seed mix—use on the hillslope areas at the site.
- Drainage bottom areas seed mix—use along drainage bottoms at the site (depending on the hydrology at a location, this may be combined with the wetland areas seed mix).
- Wetland areas seed mix—use for wetland areas at the site.
- Temporary seeding seed mix 1—use for temporary cover.
- Temporary seeding seed mix 2—use for temporary cover.

These seed mixes may be modified for specific projects as warranted. All revegetation projects at the site must involve the Rocky Flats ecologist, who will coordinate with project management to provide project-specific revegetation specifications (e.g., seedbed preparation, soil amendments) to go into the Statement of Work. This approach is required because of the complexity of the landscapes and regulatory/compliance issues in Preble's mouse habitat and wetland areas at the site. The Rocky Flats ecologist or designee must also be contacted for all erosion control requirements at the site prior to project initiation. The *Erosion Control Plan for Rocky Flats Property—Central Operable Unit* (DOE 2007) will be used to address erosion control issues for revegetation projects.

2.3 Soil Characterization

Soil characterization of several revegetation locations representative of general IA conditions was conducted during the summer of 2003. The soil sampling plan and results are presented in Appendix B. No nitrogen amendments were applied to any of the revegetation areas because scientific evidence indicated that the addition of nitrogen would foster weed growth at the expense of desired species. If needed, additional location-specific soil characterization for revegetation factors may be conducted.

2.4 Prohibited Species

The plant species listed below are prohibited for use at the site because (1) they are nonnative species, and (2) they are aggressive and outcompete many of the native species.

- Annual rye grass *Secale cereale*
- Bulbous bluegrass *Poa bulbosa*
- Crested wheatgrass *Agropyron desertorum* or *Agropyron cristatum*
- Intermediate wheatgrass *Agropyron intermedium*
- Johnsongrass *Sorghum halepense*
- Orchardgrass *Dactylis glomerata*
- Quackgrass *Agropyron repens*
- Sheep fescue *Festuca ovina*
- Smooth brome *Bromus inermis*
- Timothy *Phleum pratense*
- Wild proso millet *Panicum milaceum*

The use of a sterile hybrid of wheat known as ReGreen is allowed under certain conditions at the site; however, prior approval from the Rocky Flats ecologist is required.

The use of any nonnative species at the site is only allowed with prior approval by the Rocky Flats ecologist and will only be considered under very special conditions. No species found on the Colorado State noxious weed list or the Jefferson County noxious weed list are allowed to be planted at the site.

3.0 Long-Term Monitoring and Management

Monitoring and management of the revegetation areas may be required for several years until the vegetation has been reestablished. The following considerations can be adapted and changed as necessary to achieve the desired goals and success criteria for the revegetation areas.

3.1 Revegetation Management

Management of the revegetation areas is critical to final success. Management measures may include weed control, reseeding areas as necessary, thinning vegetation through fire or other mechanical means, relocating or eliminating undesirable wildlife species, incorporating erosion control measures, and controlling or limiting anthropogenic activities within revegetated areas. The *Rocky Flats, Colorado, Site Vegetation Management Plan* (DOE 2008) outlines the integrated weed management program for the site and addresses potential tools that may be used to help establish desired vegetation while controlling noxious weeds. Initial success of all revegetation efforts is not a guarantee of long-term viability. Many factors can influence the success of revegetation. Some of these factors include variable climate (precipitation amounts, timing of precipitation events, temperatures), seedbed preparation, seed viability, soil fertility, undesirable species competition for resources, and herbivory. Even if all these factors are favorable and conditions are conducive for revegetation success, a planting may fail. Therefore, a revegetation project the size of that at Rocky Flats should have appropriate monitoring and management to increase the chances that initial revegetation efforts will succeed.

Time is a critical factor for establishing a native revegetation planting, and it will take several years for the revegetation areas to begin to resemble the native prairies found on the undisturbed portions of the site. It is normal for any revegetation effort to go through an initial stage of annual weeds followed by the establishment and dominance of the desired perennial species. Depending on the weed species, however, weed control is not always immediately warranted. Species such as *Kochia scoparia*, *Salsola iberica*, *Helianthus annuus*, *Erodium cicutarium*, and various annual mustard species are often common at the site during the first 2 or 3 years of a revegetation effort. These species are adapted to the early successional environmental conditions and often will not substantially reduce the growth and development of the desired perennial species. The species can actually protect the developing perennial vegetation by creating shade, providing a buffer from the wind, and creating favorable moisture conditions. In addition, they provide additional organic matter to the topsoil. After the first 2 or 3 years of establishment, control of the annual species may be desirable. However, control of noxious weeds should be conducted as regulated and as needed, using appropriate control methods (DOE 2008).

Native plants often take longer to germinate and establish than nonnative species. For the first year or two, many native species spend most of their energy developing a substantial root system before sending up much aboveground growth. Therefore, reseeding is not always an immediate recommendation if some establishment is taking place. Reseeding is recommended only after it is determined that the desired perennial vegetation is not progressing adequately toward the revegetation goals and success criteria. Two potential scenarios may trigger reseeding efforts: (1) bare areas greater than 500 square feet exist over the course of a single growing season, and (2) after four growing seasons, quantitative data show that the total vegetation cover is less than 70 percent of the success criteria (Section 3.2).

Access to the revegetation areas may be restricted to provide the greatest opportunity for success of the revegetation effort. Access may be restricted through the use of fencing, signage, and education, as needed.

3.2 IA Revegetation Success Criteria

Success criteria and monitoring are an important component of a revegetation project. Revegetation success is typically judged according to criteria for species richness, species composition, and total ground cover. These criteria are important indicators of site conditions and stability, and they can be adjusted as desired to achieve the objectives. Also, conditions at some locations may never reach specified success criteria simply because the physical, environmental, and climatic factors at a location are not conducive for substantial vegetative growth. Situations such as this currently exist at some locations on the native prairie at the site. These success criteria are provided as initial guidance; however, common sense combined with scientific data must be applied to final evaluations to determine whether further management actions are required. The success criteria also depend on the goals or requirements for establishment of a good stand of vegetation at a specific location.

Quantitative grassland success criteria

- The revegetation site will have a minimum of 30 percent relative foliar cover of live desired species (seeded or nonseeded native species). Relative cover is defined as the percentage of cover of a given species divided by the total amount of vegetation cover present. Example: Species A has 20% absolute cover, and total vegetation cover (all individual species cover values summed) is 80%. Relative cover = $(20/80) \times 100 = 25\%$.
- The revegetation site will have a minimum of 70 percent total ground cover that comprises litter cover, current year live vegetation basal cover, and rock cover.
- A minimum of 50 percent of the seeded native species will be present at the revegetation site.
- No single species will contribute more than 45 percent of the relative foliar cover (except in areas where dominance by a single species is appropriate for long-term wildlife and habitat management objectives).

Noxious weeds

Noxious weeds will be evaluated on a species-specific basis, and weed control will be employed as necessary using appropriate integrated weed management strategies (DOE 2008) to achieve the success criteria listed above.

Monitoring will be conducted annually at selected locations to provide information necessary for planning of management activities. Monitoring should be continued until success criteria have been achieved at the selected monitoring locations or until determined to be unnecessary. The success criteria and monitoring described here do not necessarily apply to revegetation where other regulatory drivers take precedence (e.g., Preble's mouse habitat, wetlands, landfill covers). These locations may have their own monitoring protocols and success criteria.

3.3 Revegetation Monitoring Methodology

Revegetation monitoring will consist of a two-fold approach that uses both qualitative and semiquantitative methods. Qualitative monitoring will be conducted through the use of permanent photo points and field notes. Photo points will be visited at least annually. Additional

photographs may be taken at other times if necessary. Both landscape and quadrat photographs may be used as appropriate. Field notes will be taken to note the status of the revegetation and any management needs. Appendix C shows an example of a Qualitative Revegetation Evaluation Form that may be used to assess the revegetation locations. Qualitative evaluations may be used to evaluate the revegetation success and determine if additional management actions are needed at these locations.

Semiquantitative monitoring will consist of weed mapping and quadrat sampling. Weed mapping in the revegetation areas will be conducted as part of the sitewide weed-mapping efforts to provide information for integrated weed management (DOE 2008). Weed species to be mapped will be selected annually and mapped when most visible. Mapping data will be entered and stored in the site Geographical Information System (GIS).

Quadrats will be used to determine species richness and estimate vegetation, litter, and rock cover. A 0.5-square-meter rectangular quadrat will be used for semiquantitative revegetation monitoring. Species richness will be determined by listing all species found rooted within or overhanging the quadrat. Foliar cover by species will be estimated visually using the Daubenmire cover class system (Table 1). The midpoint of each cover class will be used for analysis. Estimates of total foliar and basal vegetation cover, litter cover, and rock cover will also be estimated for the entire quadrat. To assist in the estimates of cover, the edges of the quadrat may be painted using the Daubenmire method to aid in the estimation of 5 percent, 25 percent, 50 percent, and 75 percent cover increments (Bonham 1989).

Table 1. Daubenmire Cover Class System

Cover Class	Range of Cover (%)	Class Midpoints (%)
1	0–5	2.5
2	5–25	15
3	25–50	37.5
4	50–75	62.5
5	75–95	85
6	95–100	97.5

(From Bonham 1989)

Revegetation areas will be divided into monitoring areas or units according to a variety of factors that may include slope, aspect, historical location information, project-specific information, seedbed preparation, erosion control type, or landmark features. Random quadrat locations will be generated for each monitoring area. Random locations will be generated using a GIS or the Visual Sample Plan software program (Hassig et al. 2005). Quadrat locations will be located in the field using a Global Positioning System unit. Data will be analyzed and summarized for each year to evaluate revegetation success and change.

4.0 References

- Bonham, C.D., 1989. *Measurements for Terrestrial Vegetation*, John Wiley and Sons, New York.
- Clark, S.V., P.J. Webber, V. Komarkova, and W.A. Weber, 1980. Map of Mixed Prairie Grassland Vegetation, Rocky Flats, Colorado. Occasional Paper No. 35. Institute of Arctic and Alpine Research. University of Colorado, Boulder, Colorado.
- DOE (U.S. Department of Energy), 2006. *Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan*, DOE-LM/GJ1207-2006, Office of Legacy Management, Rocky Flats, Colorado, Site, June.
- DOE (U.S. Department of Energy) 2007. *Erosion Control Plan for Rocky Flats Property—Central Operable Unit*, DOE-LM/1497-2007, Office of Legacy Management, Rocky Flats, Colorado, Site, July.
- DOE (U.S. Department of Energy), 2008. *Rocky Flats, Colorado, Site Vegetation Management Plan*, LMS/RFS/S04513, Office of Legacy Management, Rocky Flats, Colorado, Site.
- Hassig, N.L., J.E. Wilson, R.O. Gilbert, B.A. Pulsipher, and L.L. Nuffer, 2005. Visual Sample Plan Version 4.0 Software and User's Guide, PNNL-15247, Pacific Northwest National Laboratory, Richland, Washington, Internet: http://vsp.pnl.gov/docs_historical.stm, accessed 01/27/2009.
- SCS (Soil Conservation Service), 1980. *Soil Survey of Golden Area, Colorado*, U.S. Department of Agriculture.

This page intentionally left blank

Appendix A

Revegetation Seed Mixes

(NOTE: Revegetation specifications will be provided
in the Statement of Work for each project
because of location specific requirements.)

This page intentionally left blank

**Flat Areas Seed Mix (Areas On Pediment Tops* With Slopes Less Than 10%)
(Based on 50 seeds/sq.ft.)**

This Revegetation Specification Sheet Supersedes All Previous Revegetation Information For Rocky Flats

Date: 04/07

Scientific Name	Common Name	Variety	% of Seed Mix	# Seeds Needed	# Seeds/Lb.	# Seeds/Sq. Ft.	Lbs./Acre (PLS)
Graminoids							
Agropyron smithii	Western Wheatgrass	Arriba	20	435600	120000	10.0	3.63
Agropyron trachycaulum	Slender Wheatgrass	San Luis	10	217800	120000	5.0	1.82
Andropogon gerardii	Big Bluestem	Bonilla	10	217800	130000	5.0	1.68
Andropogon scoparius	Little Bluestem	Aldous	8	174240	225000	4.0	0.77
Bouteloua curtipendula	Side-Oats Grama	Vaughn	15	326700	190000	7.5	1.72
Bouteloua gracilis	Blue Grama	Hachita	15	326700	710000	7.5	0.46
Buchloe dactyloides	Buffalo Grass	Texoka	5	108900	45000	2.5	2.42
Koleria pyramidalis	June Grass		3	65340	2315400	1.5	0.03
Sorghastrum nutans	Indian Grass	Cheyenne	2	43560	120000	1.0	0.36
Sporobolus cryptandrus	Sand Dropseed		7	152460	5298000	3.5	0.03
Stipa viridula	Green Needlegrass	Lodorm	5	108900	115000	2.5	0.95
	Total		100	2178000		50.0	13.86

Sq. ft/acre 43560
Seeds/sq. ft. 50
Seeds needed/acre 2178000

- 1) This pounds per acre assumes drill-seeding is used. If the seed is to be broadcast, the application rates are to be doubled.
- 2) PLS = pure live seed. Be sure to specify this to the seed dealer when ordering.
- 3) The seed is to be certified weed free.

NOTE:

* The pediment tops are the upper flat surface areas at the Site.

**Hillside Slope Areas Seed Mix (Hillside Areas Or Areas With Slopes Greater Than 10%)
 (Based on 50 seeds/sq.ft.)**

**This Revegetation Specification Sheet Supercedes All Previous Revegetation Information For Rocky Flats
 Date: 04/07**

Species	Common Name	Variety	% of Seed Mix	# Seeds Needed	# Seeds/Lb.	# Seeds/Sq. Ft.	Lbs./Acre (PLS)
Graminoids							
Agropyron dasystachyum	Thickspike Wheatgrass	Critana	5	108900	150000	2.5	0.73
Agropyron smithii	Western Wheatgrass	Arriba	23	500940	120000	11.5	4.17
Agropyron trachycaulum	Slender Wheatgrass	San Luis	15	326700	120000	7.5	2.72
Bouteloua curtipendula	Side-Oats Grama	Vaughn	13	283140	190000	6.5	1.49
Bouteloua gracilis	Blue Grama	Hachita	24	522720	710000	12.0	0.74
Buchloe dactyloides	Buffalo Grass	Texoka	10	217800	45000	5.0	4.84
Stipa viridula	Green Needle Grass	Lodorm	10	217800	180000	5.0	1.21
	Total		100	2178000		50.0	15.90
Sq. ft/acre			43560				
Seeds/sq. ft.			50				
Seeds needed/acre			2178000				

- 1) This pounds per acre assumes drill-seeding is used. If the seed is to be broadcast, the application rates are to be doubled.
- 2) PLS = pure live seed. Be sure to specify this to the seed dealer when ordering.
- 3) The seed is to be certified weed free.

Drainage Bottom Areas Seed Mix
(Based on 50 seeds/sq.ft.)

This Revegetation Specification Sheet Supercedes All Previous Revegetation Information For Rocky Flats

Date: 04/07

Wet Areas Along Edge of Streambank or Pond Edge							
Scientific Name	Common Name	Wetland Designation	% of Seed Mix	# Seeds Needed	# Seeds/Lb.	# Seeds/Sq. Ft.	Lbs./Acre (PLS)
Graminoids							
Agrostis scabra	Hair Grass	FAC	20	435600	5000000	10.0	0.09
Carex nebrascensis	Nebraska Sedge	OBL	25	544500	534000	12.5	1.02
Eleocharis palustris	Longstem Spike Rush	OBL	10	217800	1240000	5.0	0.18
Juncus balticus	Baltic Rush	OBL	25	544500	500000	12.5	1.09
Scirpus americanus	Three-Square	OBL	15	326700	600000	7.5	0.54
Shrubs							
Amorpha fruticosa	Wild Indigo	OBL	5	108900	77000	2.5	1.41
	Total		100	2178000		50.0	4.33

Dryer Areas Away From Edge of Streambank or Pond Edge							
Scientific Name	Common Name	Variety	% of Seed Mix	# Seeds Needed	# Seeds/Lb.	# Seeds/Sq. Ft.	Lbs./Acre (PLS)
Graminoids							
Agropyron smithii	Western Wheatgrass	Arriba	15	326700	120000	7.5	2.72
Agropyron trachycaulum	Slender Wheatgrass	San Luis	20	435600	120000	10.0	3.63
Andropogon gerardii	Big Bluestem	Bonilla	15	326700	130000	7.5	2.51
Bouteloua gracilis	Blue Grama	Hachita	10	217800	710000	5.0	0.3
Elymus canadensis	Canada Wildrye	-	20	435600	115000	10.0	3.79
Panicum virgatum	Switchgrass	Nebraska 28	20	435600	390000	10.0	1.12
	Total		100	2178000		50.0	14.08

Sq. ft/acre 43560
Seeds/sq. ft. 50
Seeds needed/acre 2178000

- 1) This pounds per acre assumes drill-seeding is used. If the seed is to be broadcast, the application rates are to be doubled.
- 2) PLS = pure live seed. Be sure to specify this to the seed dealer when ordering.
- 3) The seed is to be certified weed free.

**Wetland Areas Seed Mix
 (Based on 50 seeds/sq.ft.)**

**This Revegetation Specification Sheet Supercedes All Previous Revegetation Information For Rocky Flats
 Date: 04/07**

Scientific Name	Common Name	Wetland Designation	% of Seed Mix	# Seeds Needed	# Seeds/Lb.	# Seeds/Sq. Ft.	Lbs./Acre (PLS)
Agrostis scabra	Hair Grass	FAC	10	217800	5000000	5.0	0.04
Carex nebrascensis	Nebraska Sedge	OBL	5	108900	534000	2.5	0.20
Eleocharis palustris	Longstem Spike Rush	OBL	15	326700	1240000	7.5	0.26
Juncus balticus	Arctic Rush	FACW	10	217800	8000000	5.0	0.03
Juncus torreyi	Torrey's Rush	FACW	15	326700	12300000	7.5	0.03
Scirpus acutus	Hard-stem Bulrush	OBL	7	152460	405000	3.5	0.38
Scirpus americana	Three-Square	OBL	5	108900	600000	2.5	0.18
Scirpus validus	Softstem Bulrush	OBL	13	283140	550000	6.5	0.51
Spartina pectinata	Prairie Cordgrass	FACW	20	435600	197000	10.0	2.21
	Total		100	2178000	28826000	50	3.85

Sq. ft/acre 43560
 Seeds/sq. ft. 50
 Seeds needed/acre 2178000

- 1) Rate assumes broadcast seeding.
- 2) PLS = pure live seed. Be sure to specify this to the seed dealer when ordering.
- 3) The seed is to be certified weed free.

Temporary Seeding Seed Mix 1
(Based on 50 seeds/sq.ft.)

This Revegetation Specification Sheet Supercedes All Previous Revegetation Information For Rocky Flats
Date: 04/07

Species	Common Name	Variety	% of Seed Mix	# Seeds Needed	# Seeds/Lb.	# Seeds/Sq. Ft.	Lbs./Acre (PLS)
Agropyron smithii	Western Wheatgrass	Arriba	25	544500	120000	12.5	4.5
Agropyron trachycaulum	Slender Wheatgrass	San Luis	40	871200	120000	20.0	7.3
Bouteloua curtipendula	Side-oats Grama	Vaughn	35	762300	190000	17.5	4.0
	Total		100	2178000		50.0	15.8
Sq. ft/acre			43560				
Seeds/sq. ft.			50				
Seeds needed/acre			2178000				

- 1) This pounds per acre assumes drill-seeding is used. If the seed is to be broadcast, the application rates are to be doubled.
- 2) PLS = pure live seed. Be sure to specify this to the seed dealer when ordering.
- 3) The seed is to be certified weed free.

Temporary Seeding Seed Mix 2
(Based on 50 seeds/sq.ft.)

This Revegetation Specification Sheet Supercedes All Previous Revegetation Information For Rocky Flats
Date: 04/07

Species	Common Name	Variety	% of Seed Mix	# Seeds Needed	# Seeds/Lb.	# Seeds/Sq. Ft.	Lbs./Acre (PLS)
Agropyron trachycaulum	Slender Wheatgrass	San Luis	90	1960200	120000	45.0	16.3
Triticum aestivum x Elytrigia elongata	ReGreen®		10	217800	11000	5.0	19.8
	Total		100	2178000		50.0	36.1

Sq. ft/acre 43560
 Seeds/sq. ft. 50
 Seeds needed/acre 2178000

- 1) This pounds per acre assumes drill-seeding is used. If the seed is to be broadcast, the application rates are to be doubled.
- 2) PLS = pure live seed. Be sure to specify this to the seed dealer when ordering.
- 3) The seed is to be certified weed free.

Appendix B

IA Revegetation Areas Soil Characterization Data From Summer 2003

This page intentionally left blank

Industrial Area Revegetation Plan Soil Sampling

Problem

After remediation activities have been completed in the Industrial Area (IA) for various projects, revegetation of the locations is necessary to prevent soil erosion and to return the areas to a more native state. The seedbed into which seeding will take place consists of the material left after the remediation portion of the project is completed. Soil characterization sampling is being done to characterize soil conditions at revegetation locations to determine whether soil amendments will need to be added for optimal plant growth. For the best revegetation success it is important to know if any soil parameters are outside the range required for optimal plant growth.

Identification of Decisions

The characterization sampling and analysis question to be evaluated is:

1. Do the selected soil parameters at the revegetation locations fall within the range specified for optimal plant growth and revegetation success (Savage and Savage 2003)?

Inputs to the Decisions

Information needed to evaluate the confirmation sampling and analysis question are as follows:

1. List of soil parameters to measure and the range of optimal values for each parameter. See Table 1 below.

Table 1. Soil Parameters To Be Measured

pH
Electrical Conductivity (EC; mmhos/cm)
Sodium Adsorption Ratio (SAR)
Saturation (%)
Boron (ppm)
Selenium (ppm)
Textural Class
Coarse Fragments
Nitrogen (NO₃)
 < 1% organic matter
 1-2% organic matter
 >2% organic matter
Phosphorus
Potassium

2. Soil sampling locations.
3. Sampling results.

Study Boundaries

Samples will be collected from each of three broad categories identified for different seed mixes in the IA: flat areas, hillside slope areas, and drainage bottom areas. Figure 1 shows the general locations where soil samples will be taken initially. As additional areas are prepared for revegetation, additional samples may be collected.

For the flat area category (representing the pediment top in the IA), the solar ponds and the building footprints for T893A, T893B, and 125 have been selected for initial sampling. A total of three composite samples will be taken from these areas—one from the solar ponds, one from the T893A and T893B buildings, and one from Building 125. For the hillside area category, three samples will be taken—one from the north-facing hillside where Buildings 993 and 987 were located, one from the old Perimeter Intrusion Detection Assessment System (PIDAS) area west of the waste water treatment plan that was regraded as part of the solar pond project, and a one from a small disturbance along the north access road where a fence corner was removed. Table 2 summarizes the locations and number of samples to be taken. As additional hillside areas in the IA are prepared for revegetation, additional sampling will be conducted. For the drainage bottom categories, no samples will be taken currently since no areas in this category have been disturbed. Sampling for these areas will be conducted when these areas become ready for revegetation.

Table 2. Soil Sampling Locations and Number of Samples

Location	# of Samples	# Subsamples for Compositing
Solar Ponds	1	15
T893A and T893B	1	10
Building 125	1	10
Fence corner	1	4
Old PIDAS	1	10
Buildings 993 and 987 area	1	10
Total # Samples	6	

The soil samples will be collected and shipped to an off-site soil laboratory for analysis. A composite sample of the top 18 inches of plant growth medium from representative locations within the revegetation parcels will be collected for each sample. Specific locations for representative subsamples within the revegetation parcels will be subjectively selected and flagged in the field by site ecologists. Randomization of subsamples is not required so that the apparent visual variability can be taken into account. Samples will be taken from areas recently revegetated. The subsamples from each location will be composited into one sample for each area to be sent to the laboratory for analysis. Site procedures and policies will be followed for the collection and shipping of samples. Soil volumes collected will be consistent with the amounts needed to conduct the laboratory analyses. Table 1 lists the soil parameters that are to be measured.

Results will be provided in hardcopy and electronic form to the K-H Ecology Group.

Decision Rules

The sampling and analysis decision rules that describe how the data will be evaluated are listed below.

1. Laboratory results for each composite sample will be compared to the range of suggested optimal values the CDMG column in Table 1 from Savage and Savage (2003). If any of the values for the parameters measured fall outside the optimal values listed in Table 1 evaluation of potential corrective actions will be taken.

Tolerable Limits on Decision Errors

The composite sampling method will provide a good overall measure of the soil conditions present at the revegetation locations. No statistical analysis is required or necessary for these data. A simple descriptive comparison of laboratory results to the values in Table 1 will be sufficient for the level of accuracy and scope required.

Optimization of Plan Design

Optimization of this sampling design does not need to meet rigorous statistical analysis. It is a simple descriptive comparison of laboratory results to the values in Table 1 in Savage and Savage (2003) will be sufficient for the level of accuracy and scope required.

References

Savage and Savage, 2003. *Rocky Flats Environmental Technology Site Industrial Area Revegetation Plan*, Final Draft, Prepared by Savage and Savage, Inc., Louisville, Colorado, for Kaiser-Hill Company, LLC., January.

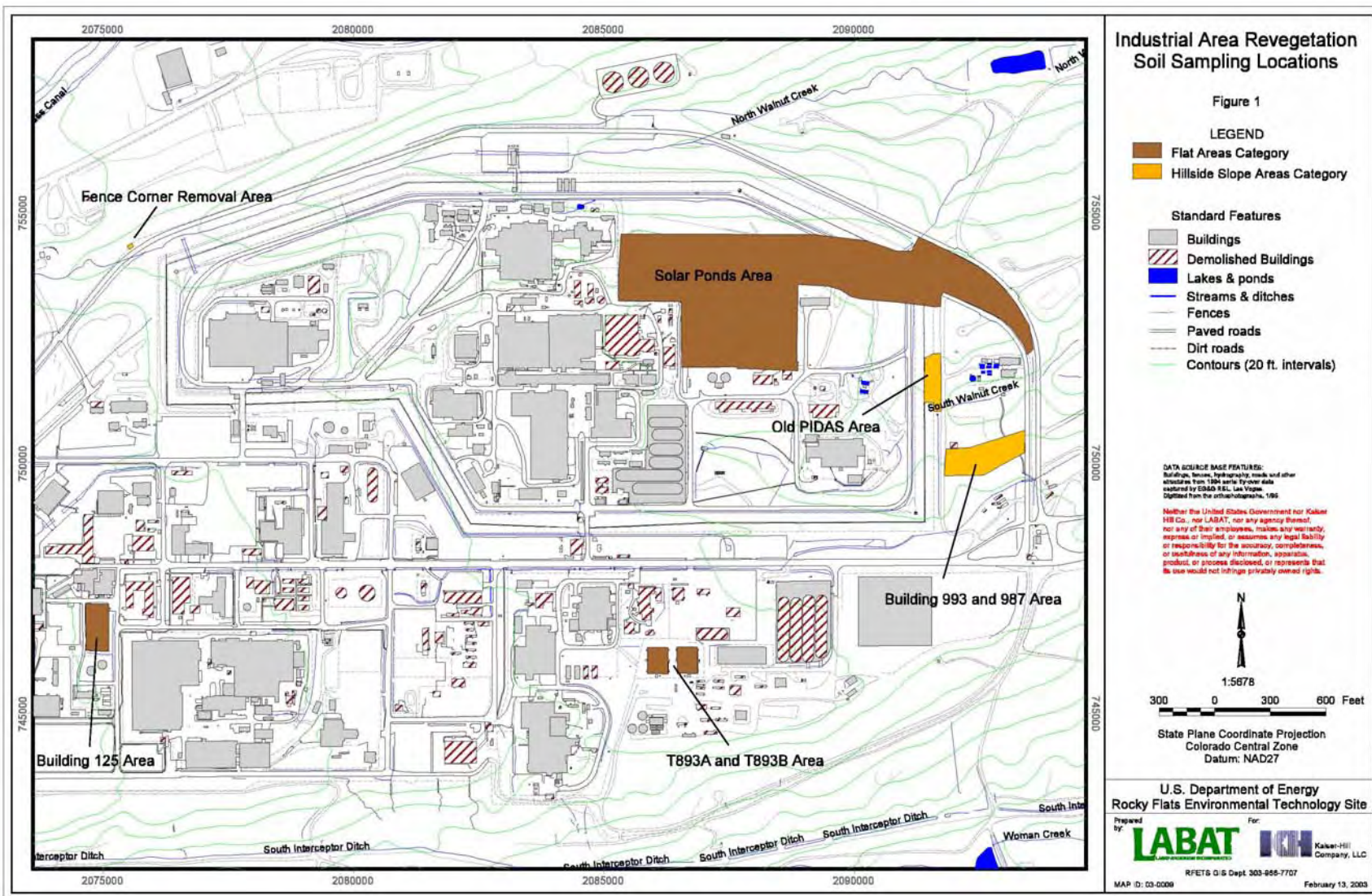


Table 1. Rocky Flats Industrial Area Revegetation Soil Sampling Summary

Soil Variable	Mesic		Xeric		CDMG*
	Mean	SD	Mean	SD	
Nitrogen (ppm)	4.27	2.72	5.93	4.06	<6 ppm
% Organic Matter	1.66	0.43	1.39	0.45	1-2
Phosphorus (ppm)	4.67	2.31	4.33	2.31	<3 ppm
Potassium (exchan; ppm))	170.00	60.00	126.67	15.28	<60 ppm
pH	7.43	0.29	8.23	1.01	<5.5, >8.8
Electrical Conductivity (mmhos/cm)	0.58	0.13	1.55	0.96	>8.0
SAR	1.17	0.72	1.50	1.11	>10
% Saturation	38.77	1.35	32.73	8.24	<25, >80
Boron (ppm)	0.07	0.02	0.25	0.28	>5 ppm, (pH >8.0)
Selenium (ppm)	0.00	0.00	0.00	0.00	>2.0, (pH >8.0)
Soil Texture	Loam		Loam, sandy loam		clay, siltclay, sand

n = 3 for each habtype

* CDMG = Colorado Division of Minerals and Geology unpublished guidance document (Savage and Savage, 2003)

This page intentionally left blank

Appendix C

Qualitative Revegetation Evaluation Form

This page intentionally left blank

Qualitative Revegetation Evaluation Form

Form # _____

Date _____

Observer(s) _____

Location ID _____

Photographs taken today? Y N

Are seeded plant species present? Y N

Which seeded species are present? How abundant are the seeded species? Estimate overall cover of each seeded species using the following cover class system (1 = <5%; 2 = 6-25%; 3 = 26-50%; 4 = 51-75%; 5 = >75%). Comments on their condition.

Any evidence of nutrient or water deficiencies? If so, describe. _____

Are noxious weeds present? Y N

If yes, what species of noxious weeds are present? How abundant are the noxious weed species? Estimate overall cover of each noxious species using the following cover class system (1 = <5%; 2 = 6-25%; 3 = 26-50%; 4 = 51-75%; 5 = >75%).

Are other weedy species present? Y N

If so, what species and how abundant are they? Estimate overall cover of each weedy species using the following cover class system (1 = <5%; 2 = 6-25%; 3 = 26-50%; 4 = 51-75%; 5 = >75%).

Total Vegetation Cover (Estimate to nearest percent) _____

Suggestions for management: _____

Other comments: _____

Completed by: _____ Date _____
Print Sign